

***Research and Services Capabilities  
at  
Fayetteville State University***



**Daryush ILA, Ph.D.**

Associate Vice Chancellor for Research & TTO

# ***FSU Background (I)***

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- Established 155 years ago
- Nearly 6200 students
- All programs are accredited by SACCS
- Forensics degree, training/services
- Intelligence Study degree program
- Top ranked SBE (SSRN network)

[http://www.ssrn.com/institutes/top\\_institutions\\_transfer\\_files/top\\_institutions\\_transfer\\_files.htm](http://www.ssrn.com/institutes/top_institutions_transfer_files/top_institutions_transfer_files.htm)



# ***FSU Background (II)***

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- **Criminal Justice degree program**  
(Certified by academy criminal justice science)
- Advanced degrees in computer sciences, Chemistry, Physics, Biology and Chemistry with Materials track
- 3/2 Engineering program with NCSU;
  - Chemical Engineering,
  - Computer Engineering,
  - Electrical Engineering, and
  - Civil Engineering



# Core Facility

## Focus Area:

### Research and Development services

- Materials Characterization,
- Imaging,
- Synthesis, &
- Analytical Chemistry



## Current Projects/Sponsors:

- DOD, DoEd, NSF, Industries, State, FSU
- FSU Departments of:
  - Chemistry
  - Physics
  - Biology
  - Computer Science
  - Research

## Project Description:

**To provide** state-of-the-art capabilities for FSU and the local community in support of cutting-edge research, transformative hands-on education, and technical development.

<http://www.uncfsu.edu/research/core-facility-initiative>

### Major Available Instrumentation:

Atomic Absorption Spectrometry, Hyperprobe/Microprobe, Atomic Force Microscope, High Res, Mass Spect, Gas Chromatography, High Performance Liquid, Chromatography FTIR, Raman Spectroscopy, Scanning Electron Microscopy, X-Ray Diffractometer, Mechanical testing systems and more

## Collaborations:

- US Department of Education
- National Science Foundation
- Department of Defense
- Industries
- Universities

### Contact Information:

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# Prototyping Lab

## Inventor Space

*Where Imagination Becomes Reality*



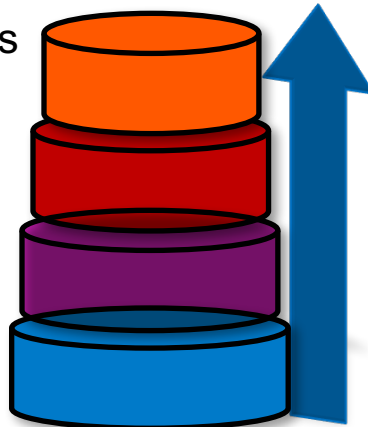
## Current Projects

- Agro-tiling for extreme environment
- Medical Devices
- Nanocrystal production & applications
- Thermoelectric Devices & applications
- Pollution Remediation
- Green pest control
- Laser - Propulsion and attitude control

## Description

**To provide.** Outlets Inventions, for both On-campus and Off-Campus Visionaries

- Space
- Equipment
- Facilities
- Expertise



## Collaborations

- Inventors/Visionaries
- Small Businesses
- Federal Agencies
- US Army Research Lab
- US Army Med. Command
- Industry

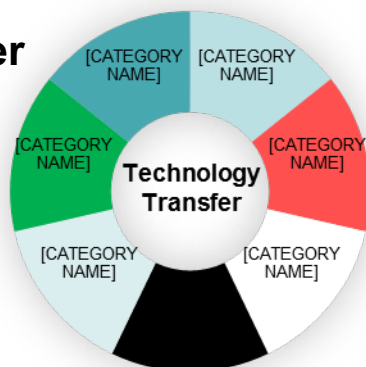
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<http://www.uncfsu.edu/research/prototyping-validation-and-verification-initiative>

# Innovation & Technology Transfer

## Focus Areas

- Innovation & Invention
- Patenting (IP)
- Technology Transfer
- Start-ups
- Commercialization
- Licensing



## Current Projects/Sponsors

- Innovation Fund NC
- iMatSci
- Fayetteville State University
- Industry
- Others

## Current Start-ups

Next Generation  
Biomedical LLC, .....

## Description

**To provide.** Outlets for Innovation and Inventions Through, Intellectual Property Protection (Patents, Copyrights & etc.), Technology Transfer (Commercialization and Licensing) and promoting University Start-ups.

## Current Patents:

- Silica-Based Plant Growth Medium (2 patents)
- Novel Wound Care Recovery Device
- Pest Control Composition
- Energy conversion (Heat to Electricity)

## Collaborative Research Ideas/Potential Sponsors

- Industry
- Department of Energy
- Department of Defense
- National Science Foundation
- Department of Education
- Universities
- Small Businesses

### Contact

### Information:

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<http://www.uncfsu.edu/research/innovation-and-technology-transfer>

## Market Readiness Level (FSU tool)



# Mentor Protégé

## Services at Fayetteville State University

### Focus Area

FSU provides a wealth of information technology services and solutions, computer & communications systems knowledge, network software and testing expertise, and various technical training to satisfy a protégé firm's technical requirements.

### Current Projects/Sponsors

- Cognition, LLC; RLM Communications, INC; Department of Defense; Prodigy Capital Consulting Group; NSK Security Management Solutions; Department of Homeland Security; United States Army; Lockheed Martin; Air Force Associates; K3 Enterprises
- [List of past and present partners](#)

### Description

- Assist small & disadvantage businesses
- Enhance small business' technical capabilities and business acumen
- Enable small businesses to successfully compete for government contracts and subcontracts
- [Provide certified on-line and onsite training anytime and anywhere](#)
- [Tailor the courses to specific needs of the protégé](#)
- ***Help you find a mentor, and coordinate with your program manager to set up program***

### Collaborative Research Ideas/ Potential Sponsors

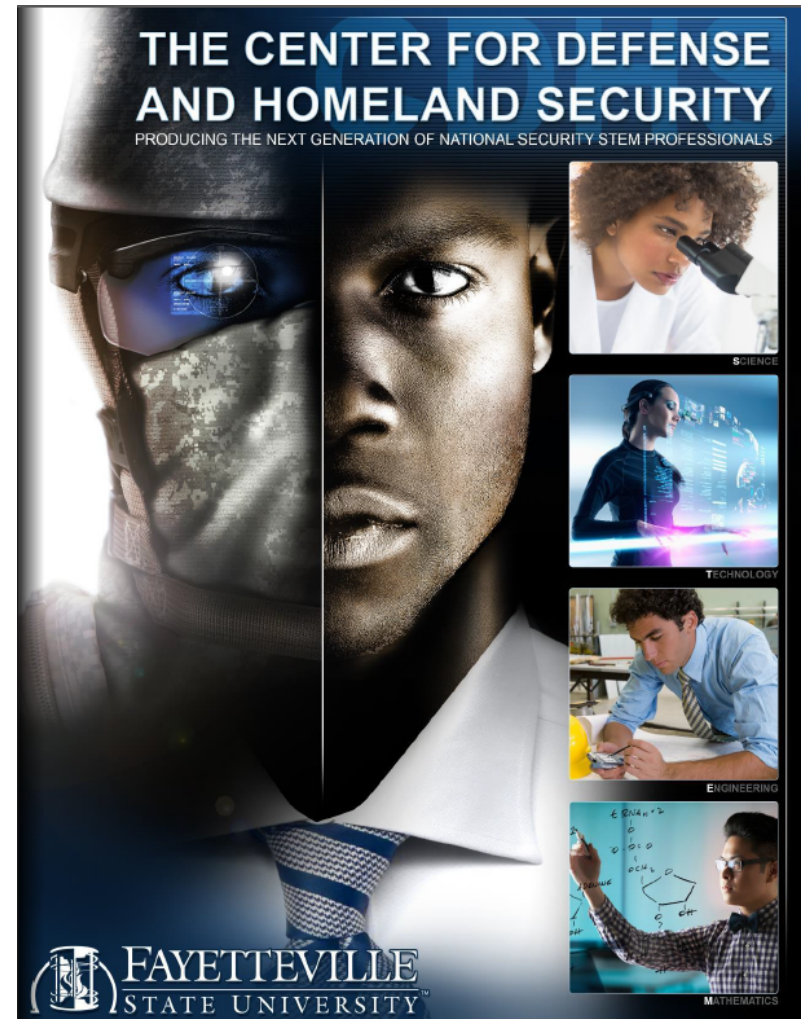
- SBA – Mentor Protégé
- DOD – Mentor Protégé
- NASA – Mentor Protégé
- SWOT analysis – DOD M&P
- Strategic planning and Business Development support --- SBA

#### Contact Information

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# The Center for Defense and Homeland Security (CDHS)

- **Develop** the next generation workforce professionals for:
  - National Security Challenges
  - Cyber Security
  - Disaster preparedness
  - STEM
- **FOCUS Areas:**
  - Intelligence studies
  - Geospatial Intelligence
  - Cyber Security
  - Analysis



**Dr. Brian Kent, Executive Director**  
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**[www.uncfsu.edu/cdhs](http://www.uncfsu.edu/cdhs)**

# Electron Microscopy & Microprobe Ctr.

## Focus Area

- The SENCRC-MIC provides state-of-the-art microanalytical and imaging capabilities.
- Cutting-edge research in Materials Science, Physics, Chemistry, Geoscience, Life Science, Engineering and so on.
- Transformative STEM education to students for hands-on research experiences.
- Forensic investigations by users from federal governmental agencies.
- Technical development to support local and nationwide industrial users.

## Description

- The SENCRC-MIC is an open platform to conduct sample structural characterizations, funded by the U.S. Army Research Office.
- The SENCRC-MIC is open for guided tours and demonstrations on an as needed basis.
- SENCRC-MIC houses state-of-the-art JEOL 8530F Electron Probe Microanalyzer (EPMA) with field-emission source (the only one in NC and surrounding states), JEOL 6510LV SEM, Agilent 5500 AFM/SPM, Rigaku MiniFlex 600 XRD, light microscopes with CCD cameras, and completed sample preparation equipment.

## Current Projects/Sponsors

- FSU major users: Drs. Zhiping Luo, Shubo Han, Daryush Ila, Cevdet Akbay, Alexander Umantsev, Khalid Lodhi, Lieceng Zhu.
- Funded projects: DoD ARO (Contract W911NF-14-1-0060). \$464,543. 02/01/2014 – 07/31/2015; NSF HRD 1436120. \$400,000. 07/01/2014 – 06/30/2017.
- **External users:** East Carolina University, NCCU, North Carolina Geological Survey, NC Museum of Natural Sciences, NCSU, UNCP, and UNC–Chapel Hill, College of Charleston, USC, Lamar Univ., NASA, TAMU, and UPR at Mayaguez.

## Collaborative Research Ideas/ Potential Sponsors

- The mechanical injection method can prepare vertically aligned nanowires with lower melting points below 650 °C.
- Collaborations are needed to use different strategies to prepare nanowires with higher melting points.
- Potential sponsors: NSF, DoD, NRC.

### **Contact Information**

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(910) 672-2647

# Fayetteville State University

## Online Courses on Demand (anytime/anywhere)

### Focus Area

Through online courses, workshops, seminars and conferences, FSU online courses will help you increase your progress toward graduation, prepare for a new career, advance within your current profession, learn new skills and improved your quality of life.

### Typical Students

- FSU employees
- Freelance or consultants
- Single student seeking national certification training
- Those seeking new career paths
- Military
- Displaced workers
- WIA

### Description

Students who enroll in JER Online courses are either individuals, employees of a company, consultants and freelancers or those seeking new career choices. Start anytime or on a fixed time schedule and access your course anytime from anywhere for fast completion.

### Collaborations

- Fayetteville State University with
- US Army and
- Industries

#### Contact Information

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# THANK YOU!

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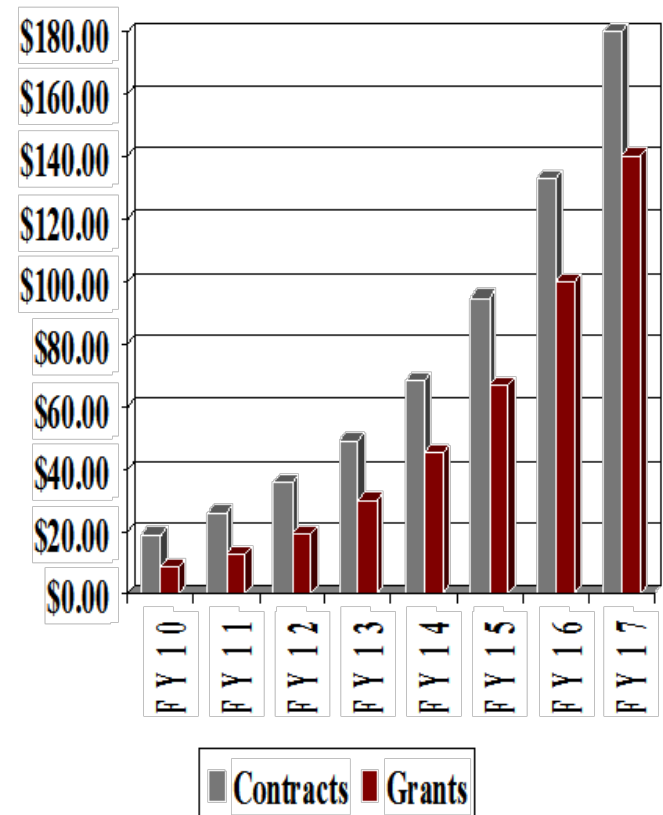
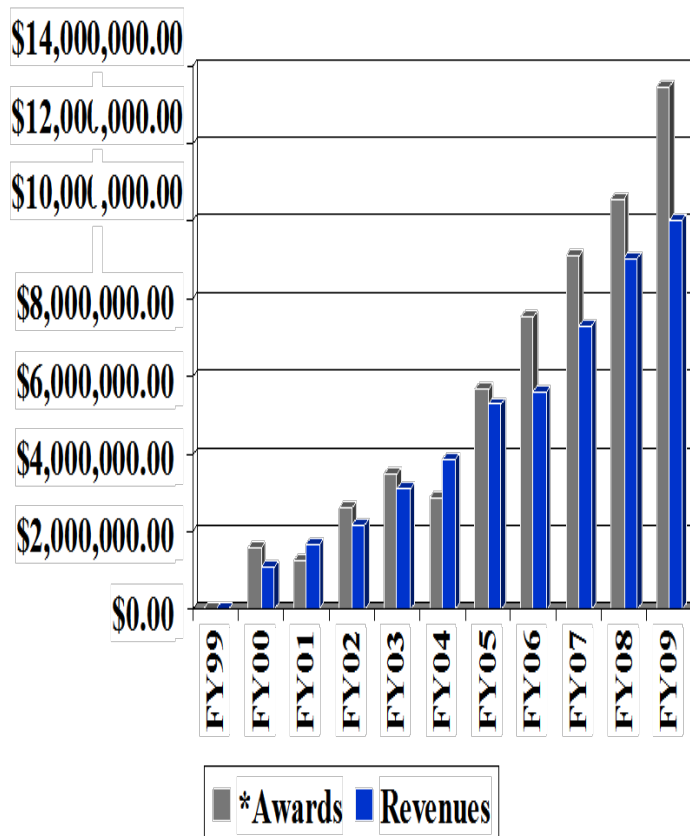


# **Can do it conduit**

**Over three dozen MPP contracts  
and  
seven years in a row received eighteen Nunn-Perry  
Awards**

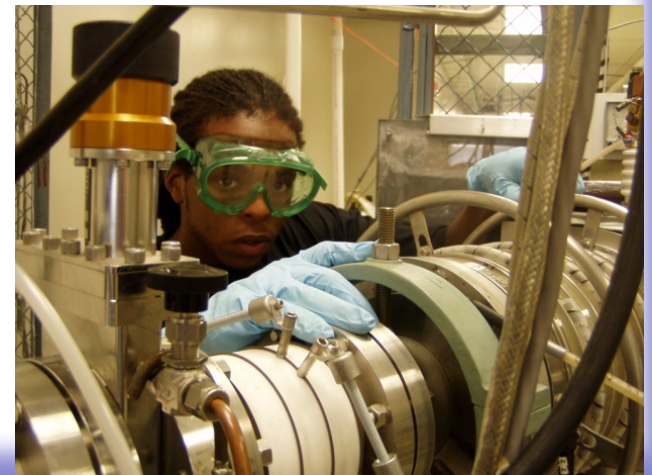
# Sample portfolio (Actual)

- ✓ First ten years (Conservatively)
- ✓ Second ten years (forecasted)



# **Other Relevant Research**

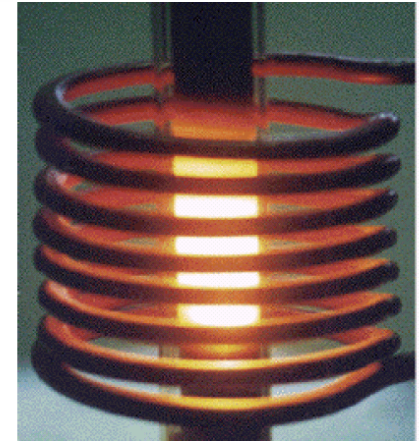
**Surface and interface engineering  
(adhesion, thermal cycling,  
electrical, optical, thermoelectric,  
thermo- luminescence, thermal  
signature, hydrogen embrittlement,  
hydrogen sensing, ...)**



# Carbon Composites and GPC

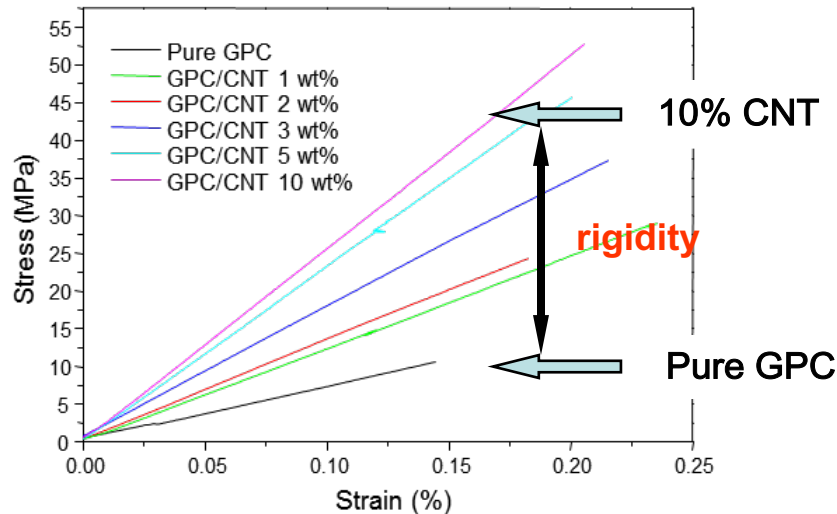
**GPC is high temperature materials, ultralight high strength composites**

BULK DENSITY	Mg/m <sup>3</sup>	1.3 – 1.5
TENSILE STRENGTH	MPa	40 – 100
FLEXURAL STRENGTH	MPa	210 – 260
COMPRESSIVE STRENGTH	MPa	480 – 580
YOUNG'S MODULUS	GPa	14 – 33
GAS PERMEABILITY	mm <sup>2</sup> /s	10 <sup>-4</sup> – 10 <sup>-10</sup>
VICKERS HARDNESS	HV1	230 – 340
THERMAL EXPANSION	1/K	~ 10 <sup>-8</sup> (can be <0)
THERMAL CONDUCTIVITY	W/Km	0.238 – 1.428
ELECTRICAL RESISTIVITY	ohm m	10 – 50 x 10 <sup>-6</sup>

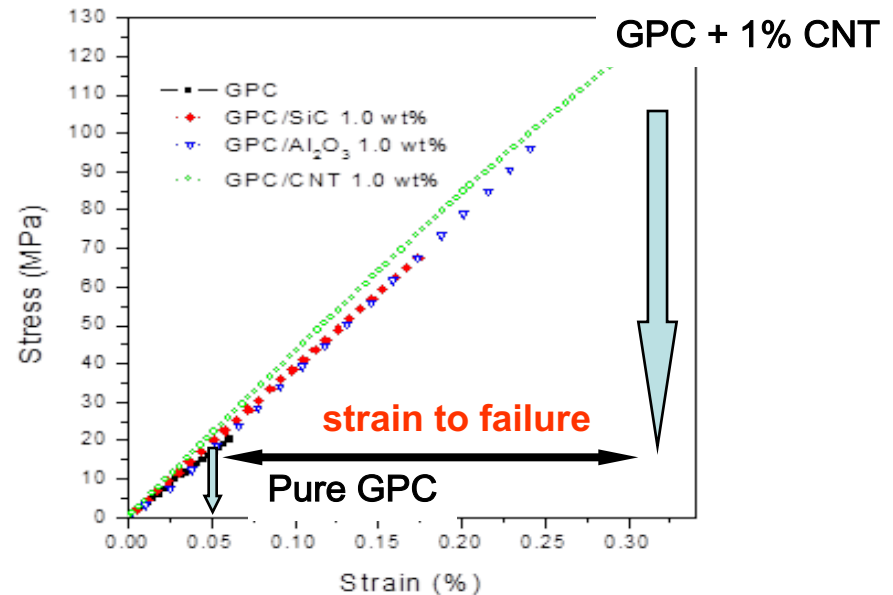
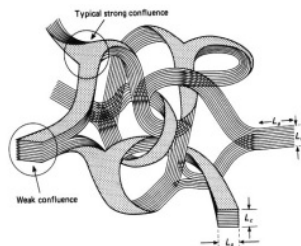


**Induction heated, in air, repeatedly, to as high as 2400 K, for several hours. Tube OD is 16mm. The maximum thermal gradient is over 200K / mm, possible because of the small thermal expansion and large strain to failure for GPC.**

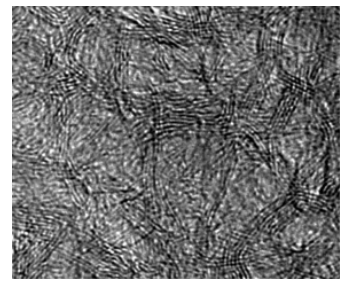
# Enhanced hardness & Controlled stiffness



Stress-strain of GPC with various concentrations of CNT in the GPC matrix. The more CNT added, the stiffer composite is.



Stress-strain curve of GPC and GPC composites. When nanopowder is added in the GPC matrix, composites material withstand more stress before fracture.



# Thermoelectric Research

Conformal, ultra-light, high volume fraction nanomaterials and highest ZT reported.

$$ZT = (S^2 \sigma T) / \kappa$$

ILA, et al TEM work as of 2016

## Present State of Art

Materials	Reported ZT/Temp	UNCFSU ZT/Temp	Potential ZT/Temp $ZT = (S^2 \sigma T) / \kappa$
SiO <sub>2</sub> Au/SiO <sub>2</sub>	0	2.52 @ 360K	> 2.52
Bi <sub>x</sub> Te <sub>3</sub> /Sb <sub>2</sub> Te <sub>3</sub>	1.1 @ 350K	2.6 @ 350K	> 2.6
SiO <sub>2</sub> Ag/SiO <sub>2</sub>	0	0.085 @ 300K	> 0.7
Zn <sub>4</sub> Sb <sub>3</sub>	0.50 @ 300K	0.53 @ 300K	Under Investigation
CeFe <sub>2</sub> Co <sub>2</sub> Sb <sub>12</sub>	0.05 @ 300K	3.07 @ 300K	> 3.5
SiO <sub>2</sub> Ag/SiO <sub>2</sub> Au & SiO <sub>2</sub> Au	Patent	3.4 @ 300K 3.88 @ 500K	> 3.8 > 3.65
Si <sub>1-x</sub> Ge <sub>x</sub> /Si	0 @ 300K 0.6 @ 1200K	0.61 @ 300K	>> 0.61

### TEM in the market

Efficiency < 17%

Operational Temp > 100°C  
(mostly)

Bulk (lowest efficiency),  
Mol. Beam Epitaxy/MBE  
(expensive)

Working in series (mostly)

Radiation sensitive (mostly)

### Our TEM (Work)

Efficiency > 25% (25-30%)

27°C to 900°C

Coating on any surface  
(Inexpensive and conformal)

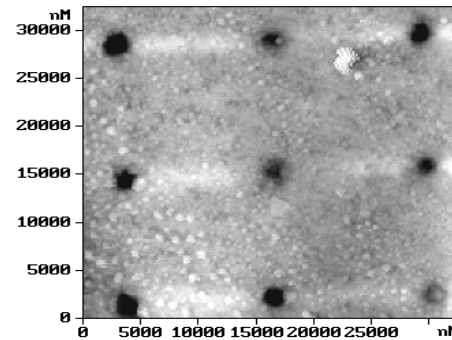
Works in parallel (tough)

Radiation resistant (mostly)

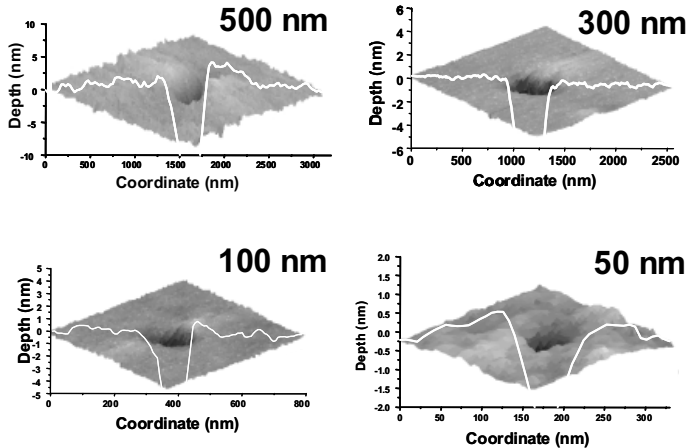
ILA, Zimmerman, and Zheng

# Controlled Fabrication of Micro-/ Nano-pores Membranes

## *Production of nanopores in Fluoropolymer films*



Nano pore production for single molecule biochemistry  
DNA and Protein characterization



Perfluoroalkoxyethylene (PFA)  
 $[\text{CF}_2\text{CF}_2]_{0.99}[\text{CF}_2\text{COF}_3]_{0.01}$

